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COMPREHENSIVE WATERSHED MANAGEMENT

Embracing integrated watershed revitalization in Suzhou, China: learning from global case studies

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Abstract

Suzhou is China's historic water town, and a sustainable approach to watershed revitalization is firmly on the agenda. The practice of integrated watershed management requires collaborative planning involving a significant number of stakeholders; no single organization can solve the problems of ecosystem management unilaterally. The changing social–political environment in China has led to the development of a new form of governance. China is in transition from the traditional government image of a regulator and a controller towards an enabler that facilitates provision and action by, and through, others. Global case studies show that sustainability issues are essential to tackling watershed ecosystem management by creating a win–win strategy for wider stakeholders. Viewed from an institutional perspective, the emergence of a new collaborative partnership model requires a different implementation process to tackle practical problems in the face of complex watershed agendas. Drawing upon global and China's experiences, the paper concludes that some planning processes require government leadership continuity, while others need bottom–up approaches.

Keywords Watershed management · Sustainability · Collaborative planning · Partnership · China governance

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1 Introduction

Watershed management practice has a long history dating back to 2000 BC (Wang et al. 2016). It has been evolving continuously to improve the natural and built environments in the watershed region. In contemporary planning, integrated watershed management has been increasingly emphasized due to the need for holistic coordination of environmental, economic, social, and political issues (Huntjens et al. 2010; Meadowcroft 1998; Pahl-Wostl 2007; Rydin 2003; Sabatier et al. 2005). However, in many cities and regions worldwide, a watershed boundary as an interconnected ecosystem does not correspond to the government's administrative boundaries. Some larger rivers and lakes are often managed by national government bodies, while some local government agencies manage small-scale watercourses separately. Consequently, it causes operational difficulties in incorporating the fragmented administrative structure and managing a watershed as a whole ecosystem. Extensive research in watershed management has shown the importance of collaborative efforts among diverse actors across traditional administrative boundaries (Behmel et al. 2018; Cortner et al. 1998; European Commission 2003; Schramm 1980; Strifling 2019).

Most studies in watershed management practice have focused on a partnership approach as an instrument for collaborative planning. In the literature on partnerships, a much-debated question is whether the operation of partnerships can coordinate various interests among stakeholders in the face of conflicts and uneven power distribution (Basco-Carrera et al. 2018; Boschet and Rambonilaza 2018; Kim and Batey 2020; Meijerink and Huitema 2017; Nikitina et al. 2010; Rouillard and Spray 2017). On the other hand, a considerable amount of literature has also addressed how a partnership can be operated more effectively and efficiently. In this context, previous studies have emphasized the importance of institutional structure (Bidwell and Ryan 2006), a consensus on visions and issues (EPA 2013; Van der Voorn and Quist 2018), collective learning opportunities (Scolobig and Lilliestam 2016), the decision-making process (Emerson and Nabatchi 2015), and trust-building among stakeholders (Basco-Carrera et al. 2017; Evers et al. 2012; Hare 2011; Linnenluecke et al. 2017). In particular, collaborative planning is seen as an essential approach in developing a shared vision and goals in watershed management that focus on ecological and social sustainability outcomes (Hayman 2011; Imperial 2001; Lysak 2006).

This research follows a case study approach and conducts an empirical study of Suzhou, a historic water town in China. The central aim of this paper is to explore a potential institutional arrangement for Suzhou that would improve the process of integrated watershed revitalization by learning lessons from the global practice of watershed management. This research focuses on the operation of collaborative partnerships driven by the governance approach—the collaboration between governmental and non-governmental bodies—to achieve the policy goal. The research in this paper is directed towards a comparative discussion on global watershed management practice to understand the policy framework, institutional arrangements, and delivery mechanisms. This research will analyze natural

resources, legislation and policy, and stakeholders involved in Suzhou watershed practice based on the findings of global case studies. This study contributes to this growing body of research by exploring how lessons learned from global case studies can be applied to the future practice of water management in Suzhou. Accepting that a collaborative partnership approach is a possible institutional arrangement for integrated watershed management, the research is also intended to establish what kind of institutional framework is most suitable for Suzhou's collaborative partnership. Again, learning from global experience, this research will identify key practical suggestions that should be applied to Suzhou to initiate the strategic dimensions in collaborative watershed management practice.

2 Watershed management in global context

2.1 Global case studies for watershed policy framework

Watershed sustainability issues are essential to tackling a river basin ecosystem management to create a win–win strategy for wider stakeholders (Kim 2002). While there are common themes in watershed management issues, such as sustainability, the priority among the local watershed management issues and problems has varied in different societies and periods. For example, priorities in developing countries may focus on water resources such as irrigation, hydroelectric power, flood protection for food security, and pollution control concerning eradicating the disease. In contrast, developed countries may prioritize their water resources focusing on water supply, recreational uses, and nature conservation (Newson 1992). Regarding watershed management principles, there are many policy guidelines published by international and national organizations. For example, at the international level, the United Nations provides practical guidelines and development issues concerning the implementation of integrated water resource management (Hassing et al 2009). At the regional level, the EU Water Framework Directive (2000/60/EC) was issued by the European Parliament and the Council of the European Union (European Commission 2000). This Directive includes the objectives and implementation plans of community action in the field of water policy. At the national level, in the case of the United Kingdom, the National Strategy and Planning for the Future has also identified vital categories of water uses in water catchment planning (National Rivers Authority 1993). To apply these guidelines and approaches from global practice to Suzhou's watershed management practice, the focus of this research, nine domains have been identified for a policy framework that can contribute to improving watershed management (Table 1).

The watershed policies from three different geographic scales—international, regional, and national—have been categorized using the three pillars of the sustainability concept. The environmental domain includes water quality, water resource, flood control, and habitat and biodiversity. The economic domain is for fisheries and agriculture, tourism and recreation, industrial development, and land use, while the social domain emphasizes public participation. These will be applied to the situation analysis framework for Suzhou's local watershed in Sect. 4.

Table 1 Nine domains for a watershed policy framework

Watershed policy case studies					
Geographic scales			International level	Regional level	National level
Organization			United Nations	European Union	National rivers authority
Watershed policy			Integrated water resources management	EU water framework directive 2000/60/EC	National strategy and planning for the future
Domains for watershed policy framework					
Environmental Domain	[1]	Water Quality	Health risks	Surface water and groundwater quality	Potable water supply, water quality management
	[2]	Water Resource	Water conservation	Groundwater quantity, Potable water supply	Potable and industrial water supply
	[3]	Flood Control	Floods and droughts	Flood protection, land drainage	Flood control
	[4]	Habitat and Biodiversity	Aquatic environment	Ecological status	Wildlife habitat
Economic Domain	[5]	Fisheries and Agriculture	Food production	Irrigation	Agriculture, fish
	[6]	Tourism and Recreation		Navigation	Navigation, water-based recreation
	[7]	Industrial Development	Water–energy relationship	Navigation, power generation	Industrial water supply, navigation, Thermal electric and hydroelectric power generation
	[8]	Land Use	Land and water		
Social Domain	[9]	Public Participation		Public information and consultation	
Source			Hassing et al 2009	European Commission 2000	National Rivers Authority 1993

2.2 Global case studies for watershed institutional arrangements

Drawing on the work of Meijerink and Huitema (2017), this research has explored 12 global case studies of institutional arrangements that have been adopted in the practice of watershed management (Table 2). The key finding is that most watershed management projects are operated by a partnership-oriented arrangement. As discussed earlier, it also illustrates the importance of coordination with a broader range of stakeholder involvement in watershed management practice. Another interesting observation is that many watershed organizations are government-led, although in each case, the degree of autonomy differs depending on the political and cultural environment. From the Mersey Basin Campaign experience in the United Kingdom (Kim, 2002), the government-sponsored credibility of the watershed organization has been seen as an attractive benefit for stakeholders to become partners of the watershed organization. 'Big name' partner organizations may provide added credibility for attracting smaller groups. The funding opportunities and credibility of the watershed organization might stimulate regional collaboration for integrated waterside management. However, the partner organizations seem not to be quite as interested in implementing the tasks of the watershed organization once the initial excitement of funding availability has died away.

There is a conflicting relationship between established watershed organizations and the central or state governance institutions in place (Meijerink and Huitema 2017). In a resource context, this is especially important, given that the autonomy of watershed organizations as independent decision-making bodies is dependent on where they receive their funding from and the delineation of their boundaries. For instance, when the watershed organizations receive funding from the European Union under the Water Framework Directive (WFD), they must follow the guidelines initiated by the WFD and participate in progress reporting to the EU throughout their process. In many cases, the boundaries of the river basins being governed transcend state lines, and thus, the governance institutions of multiple states are involved. For instance, Western Bug River's experience reported operational difficulties involved in creating a transboundary water policy (Poland–Belarus–Ukraine) under the legislation to European standards that must be coordinated between European Union (EU) members and EU neighboring countries (Leidel et al. 2012). This affects the analysis of stakeholder participation in watershed organizations, given that one organization working within multiple states might experience varying levels of stakeholder involvement and participation depending on the governance structure of each state. It is equally challenging to measure partner participation of these watershed organizations given the tension between leading agents, stakeholders, and potential influence from international or external organizations.

Based on the global experience of watershed institutional arrangements, full autonomy over the watershed's own agenda is essential. Many watershed organizations are established across administrative boundaries and hence are influenced by different economic and political systems either directly or indirectly. Therefore, global case studies emphasize coordination among watershed stakeholders and the policy delivery mechanism associated with different administrative systems, which will be discussed in the next section.

Table 2 Global case studies for watershed institutional arrangement

	Watershed Organization	Country	Organization Type	Leading Agent(s)	Stakeholders
[A]	Mersey Basin Campaign	UK	Partnership	Mersey Basin Campaign Council	Variety drawn from public, private and social sectors
[B]	Mackenzie River Basin Board	Canada	Coordinating	Government officials, provincial leaders, and Aboriginal members	Only formal included members
[C]	Oregon Watershed Enhancement Board	US	Partnership	State agency implemented as grant-making body	Citizens, local stakeholders
[D]	Westcountry Rivers Trust	UK	Partnership (Trust)	Citizen organized	Participants and directly affected local actors
[E]	Erftverband	Germany	Autonomous	AquaNES Project (external, funded by EU) Assembly of Associates, Board of Associates (internal)	Water users and polluters (mandatory Participation)
[F]	Portuguese River Basin Authorities and Councils	Portugal	Autonomous	(EU Water Framework Directive), government of Portugal	Unknown
[G]	Breede-Overberg (now Breede-Gouritz) Catchment Management Agency	South Africa	Government Agency	BOCMA Governing Board (appointments influenced by Minister of Water and Sanitation)	Engagement from public level to state level
[H]	Western Bug River Basin Administration (RBC) and Council (RBA)	Ukraine	Government Agency	State Agency for Water Management (veto power), RBCs and RBAs have majority rule, EU financial influence	Variety selected and included in formal councils
[I]	Lower Kunduz & Taloqan River Basin Agencies and Councils	Afghanistan	Government Agency	Governance divided between government authorities and community—Water Allocation Commission (WAC)	Partial inclusion of affected stakeholders
[J]	Mongolian River Basin Administrations and Councils	Mongolia	Government Agency	RBA and RBC proposals require approval by provincial and district parliaments	Representation in RBCs
[K]	Ping River Basin Committee & Mae Kuang Sub-Basin Working Group	Thailand	Coordinating	Committees and working groups highly influenced by traditional line-agencies (who have control over funding)	State and non-state actors

Table 2 (continued)

	Watershed Organization	Country	Organization Type	Leading Agent(s)	Stakeholders
[L]	Murray-Darling Basin Authority, Basin Ministerial Council, Basin Community Committee	Australia	Coordinating	Federal government coordinates basin state actions, coordinating committees report to the government for policy changes	Non-state actors consulted

Source: [B]-[L] were adapted from Meijerink and Huitema (2017)

Table 3 Watershed delivery mechanisms: global case studies

		Performance Evaluation*				Delivery Mechanism			
		Coordination	Accountability	Legitimacy	Environmental Effectiveness	Consensus Building	Facilitation	Open Participation	
[A]	Mersey Basin Campaign					●	●	●	Kim 2002; Batey 2009; 2017; Kim and Batey 2001; 2020
[B]	Mackenzie River Basin Board					●	●		Morris and de Loë 2016; https://www.mrbb.ca
[C]	Oregon Watershed Enhancement Board					●	●	●	Hibbard and Lurie 2006; Wiley et al. 2013; https://www.oregon.gov/oweb
[D]	Westcountry Rivers Trust					●	●	●	Cook et al. 2016; https://wrt.org.uk
[E]	Erftverband					●	●		AquaNES 2016; http://www.erftverband.eu
[F]	Portuguese River Basin Authorities and Councils				/	●			Hispagua Spanish Water Information System n.d.
[G]	Breede-Overberg (now Breede-Gouritz) Catchment Management Agency				/	●	●	●	Meissner et al. 2016; https://breedegouritzcma.co.za
[H]	Western Bug River Basin Administration and Council				/	●			Hagemann et al. 2014; Leidel 2012
[I]	Lower Kunduz & Taloqan River Basin Agencies and Councils					●	●		Thomas and Warner 2014
[J]	Mongolian River Basin Administrations and Councils				/	●	●		Houdret et al. 2014
[K]	Ping River Basin Committee & Mae Kuang Sub-Basin Working Group					●			Ganjanapan and Lebel 2014
[L]	Murray-Darling Basin Authority, Basin Ministerial Council, Basin Community Committee				/	●	●	●	Neave et al. 2015; Alexandra 2019 https://www.mdba.gov.au

Analysis Outcome Presentations: Performance evaluation is marked as more intense (dark gray); intense (light gray); less intense (white); and, no data (/). The delivery mechanism illustrates the primary goal delivery focus/foci of the watershed organization (marked as ●, black for stronger focus, gray for less strong focus).

*Performance evaluation categories are defined by the work of Meijerink and Huitema (2017).

2.3 Global case studies for watershed delivery mechanisms

Together with the advent of the sustainability concept, the institutional arrangements for integrated watershed management should be capable of accommodating multiple processes to address their practical complexities and dynamics. In an attempt to analyze the performance of watershed organizations, Meijerink and Huitema (2017) evaluated the performance outcomes of the above watershed organizations according to four evaluation criteria: (1) coordination across government parties and between public and private sectors; (2) accountability of watershed policies; (3) legitimacy of watershed policies; and (4) environmental effectiveness in policy delivery. Using those criteria, two of the current authors have reconstructed the performance evaluation result for each case by reviewing additional supporting documents available. The results of this evaluation are illustrated in Table 3. Two of the current authors have also analyzed the delivery mechanism of each watershed organization under three headings based on the

watershed partnership service delivery framework (see Kim 2002; Kim and Batey 2020):

- *Consensus building* is a primary tool for implementing collaborative efforts. It focuses on a process in which individual representatives engage in face-to-face dialogue to seek agreement on strategies, plans, policies, and actions.
- *Facilitation* is a means of partnership working by which member partners are engaged to deliver its services. The fundamental principle behind facilitation is to translate the partnership vision to its partners so as to stimulate member organizations to identify with its objectives and act for themselves.
- *Open participation* is a channel for a wider range of alternatives including different levels of participation and responsibilities outside of formal planning bodies. It allows wider involvement of all those interest groups willing to contribute to various aspects of partnership activities.

As this is secondary research with a small dataset, this restricts the ability to provide an in-depth investigation for each watershed case. The results drawn from the global case studies suggest that most watershed organizations are involved in consensus building activities. The emphasis on consensus building and conflict resolution was particularly noticeable in the global case studies. The watershed organizations with a more robust performance may deliver their policy goals with diverse delivery mechanisms (i.e., consensus building, facilitation, and open participation). This suggests that a strongly performing organization is not only needed for developing consensus between stakeholders but also, more importantly, for implementing actions beyond the traditional implementation procedure in the practice of planning.

3 Case study: Suzhou, China

3.1 Watershed management practice in China

While global watershed cases indicate the importance of partnership approaches to bring governmental and non-governmental efforts together, watershed partnerships are not practiced commonly in China. Instead, China's watershed management is mainly led by the government with a dual governance system: (1) watersheds are managed by different hierarchical levels of the government structure; and, at the same time, (2) there are area-based watershed management bodies (Zhu et al. 2018). First, the administrative institutions of watershed management in China are strongly hierarchical from national to local levels. At the national level, the Ministry of Ecology and Environment (MEE) and the Ministry of Water Resources (MWR) under the State Council are the primary central government bodies directly associated with the watershed management (Fig. 1). The MEE was established by the former Ministry of Environmental Protection (MEP) in 2018. In the restructuring process, the MEE expanded its roles and responsibilities by adding the task of supervising and preventing groundwater pollution, watershed

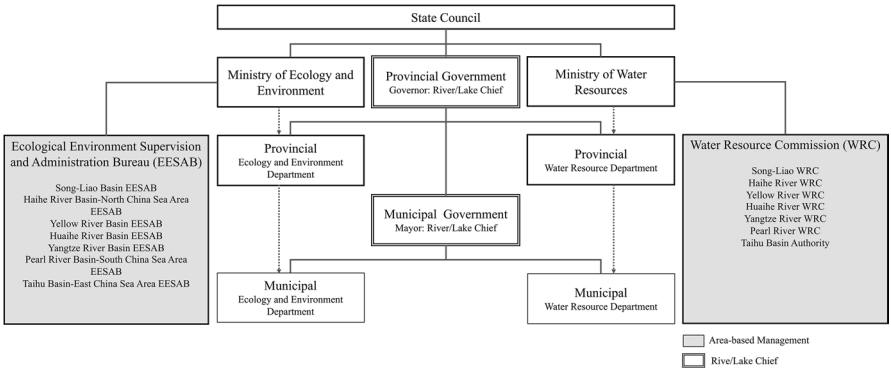

Fig. 1 The political structure of watershed management in China

protection, and agricultural non-point source pollution control (Xiong 2019). The primary responsibility of the MWR is to manage water resources by working along with regional water resource bureaus and environmental protection bureaus (Pan 2012). Another important mechanism in China's watershed management is the River and Lake Chief System. This ensures a long-term mechanism of river management and protection by working together with different local government departments (Tang et al. 2018). The local chief executives have been appointed at all administrative levels and serve as a principal coordinator for resource allocation in relation to river protection and management.

Second, in terms of area-based management, six Water Resource Commissions (WRCs) and Taihu (Lake Tai) Basin Authority are the leading government bodies at the watershed level, under direct guidance from the Ministry of Water Resources (MWR). Those are established to accommodate different local characteristics of the seven major watersheds in China. For instance, the Yellow River WRC focuses on allocating water and soil resources, construction of the water network, and improvement of the intelligent supervision system, which are the most significant local issues in the Yellow River basin (Wang et al. 2020). The Yangtze River WRC corresponds to the development of the regional economy, especially in implementing the national strategy for the Yangtze River Economic Belt. This particular WRC coordinates the development and utilization of watershed resources, economic development, pollution prevention, and ecological environment protection. The Yangtze River Protection Law was issued to improve the management system and coordinate multilateral interests in the Yangtze River basin (He 2020). The Taihu (Lake Tai) basin has been the subject of several large-scale restorations since 2007 due to the water crisis in the local area, Wuxi. As a result, the government has taken measures by building wastewater treatment plants and urban sewage pipe network systems, replacing heavy pollution industries with eco-friendly industries, and reducing aquaculture in the Taihu basin (Qin 2020). Moreover, in 2019, MEE established its own area-based watershed management authorities, Ecological Environment Supervisions and Administration Bureaus (EEASBs). The seven EEASBs are mainly responsible

for supervising the ecological environment for water resources, water ecology, and water environment closely associated with the work brief of the direct governing body, MEE.

This dual management system has advantages for tackling both hierarchical measures and area-specific issues. However, the functional conflicts between the two management systems have attracted criticism. This is particularly evident in the coordination between water 'quantity' management led by the Ministry of Water Resources (MWR) and water 'quality' management led by the Ministry of Ecology and Environment (MEE). In the real-life context, it has been challenging for area-based commissions and environmental protection departments, along with separate hierarchical management from MEE and MWR, to make a clear division of responsibilities due to the close interrelationship between water quality and water quantity issues. Those operational difficulties are also caused by ill-defined legislation on the organizational functions in the two different levels of government parties (Wang 2011). Other studies discuss the limitations of the River Chief system. First, the River Chief system was designed to enhance coordination among various government departments. However, in practice, due to the administrative structure of government institutions, a large amount of work has still to be undertaken by the Department of Water Resources (Kuang and Huang 2019). Second, there have been many practical difficulties in monitoring and managing cross-border sections, as the River Chief is only responsible for its own administrative area (Tang et al. 2018).

3.2 An overview of Suzhou

Suzhou is located in the southeast of Jiangsu Province and the middle of the Yangtze River Delta, China. As one of China's critical commercial centers since the 10th-century Song Dynasty, Suzhou has over 2,500 years of history and rich heritage resources. It is one of the most famous historic water towns in China, with the city's canals, stone bridges, and traditional gardens listed as the UNESCO World Heritage Sites in 1997 and again in 2000. Suzhou was built on the region's interlocking network of waterways, with an inner city canal network connecting to the Grand Canal and major waterworks in the region (Kim and Wang 2018). The city is characterized by a system of canals, rivers, and bridges that resemble the characteristics of the water towns in the Yangtze River Delta, and often referred to as the 'Venice of the East' or 'Venice of China' (Zhang 2018). Suzhou's government sees tourism as a catalyst for the city's socio-economic growth, as stated in the 13th Plenary Session of the Eighth Communist Party of the City. Suzhou has attracted a significant number of domestic tourists to visit the city year after year. Suzhou is adjacent to Taihu (Lake Tai), the third-largest freshwater lake in China, and the Yangtze River, the longest river in China and Asia. Integrated watershed management is critical to Suzhou ecologically, economically, culturally, and politically. The city of Suzhou consists of six districts (Gusu District, Xiangcheng District, Wuzhong District, Huqiu District, Suzhou Industrial Park, and Wujiang District) and four county-level cities (Zhangjiagang City, Changshu City, Taicang City, and Kunshan City) (Fig. 2).

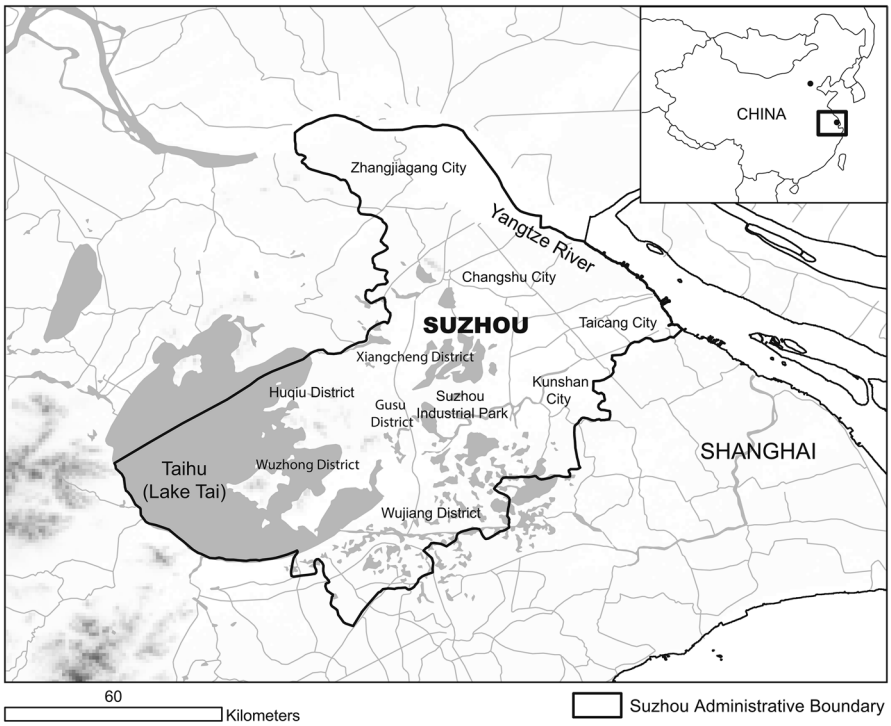

Fig. 2 The Suzhou Watershed and Administrative Boundary (water network and terrain are created using open GIS data available at www.gadm.org)

4 Understanding watershed environments in Suzhou

4.1 Situation analysis

A situation analysis is conducted to understand the potentials and limitations of the local watershed environments in Suzhou. Nine domains for watershed policy framework in Table 1 are used here: water quality, water resource, flood control, habitat and biodiversity, fisheries and agriculture, tourism and recreation, industrial development, land use, and public participation.

4.1.1 Water quality

According to the latest government report (Suzhou Ecology and Environment Bureau 2019), among 50 surface water sections included in the water quality survey of Jiangsu Province, 28% of Suzhou's water sections are in good condition (Level II, surface water for drinking water). However, 14% of Suzhou water sections are reported as of poor water quality (Level IV) that can only be used for industrial

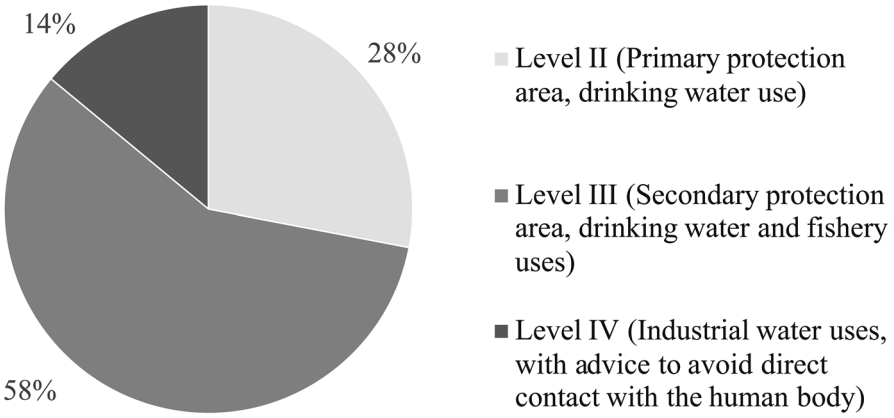

Fig. 3 The composition of provincial assessment sections water quality category in Suzhou (2019) (for the definition of each surface water quality category in detail, see http://img.jingbian.gov.cn/upload/CMSjingbian/201806/201806210945047.pdf, accessed 10 May 2021)

purposes with advice to avoid direct contact with the human body (Fig. 3). Taihu (Suzhou area), the largest single water body in Suzhou, is also categorized as Level IV in the report, and the primary water pollutants are nitrogen and phosphorus. From April to October 2019, 102 blooms were observed in Taihu (Suzhou area) through satellite remote sensing monitoring.

4.1.2 Water resources

Taken as a whole, water resources in Suzhou are abundant, but the per capita share is insufficient (Shen and Zhao 2013; Wu 2018). Shen and Tan (2015) report that Suzhou is located in the lower reaches of the Yangtze River and Taihu with a 4:6 ratio of water to land area. As Suzhou has more than 20,000 watercourses, the river network density is 1.5 km/km^2. The total amount of water resources is calculated as 3.381 billion cubic meters in total, including 2.991 billion cubic meters of surface water and 963.3 million cubic meters of groundwater, while the total water consumption is reported as 1.529 billion cubic meters (Suzhou Water Bureau 2017).

4.1.3 Flood control

One of the challenges for urban drainage in Suzhou is the rainstorms from June to September. Along with global climate change, the frequency of extreme weather in Suzhou has increased (Wu 2018), which has increased the risk of flooding. In terms of land-cover analysis, Shen and Zhao (2013) reported that Suzhou's green space rate has been increasing in recent years. However, most of this greenspace is located in urban suburbs, while the central city's impervious ground area is increasing. Their study also found that the total length of rivers in Suzhou's old town area has decreased from 82 km in the Song Dynasty to 30 km in 2013, exerting more significant pressure on the urban drainage system.

4.1.4 Habitat and biodiversity

According to the classification standard of ecological environment status, Suzhou city's ecological environment status index is 64, which means good ecological environment status (Suzhou Ecology and Environment Bureau 2019).

4.1.5 Fisheries and agriculture

Liu and Zhou (2014) found that non-point source pollution in Suzhou's watershed is mainly caused by farming, aquaculture, and ship navigation. Taking aquaculture as an example, although aquaculture pollution control technologies have been widely adopted in recent years, there are still many fish farms using traditional aquaculture methods that result in the direct discharge of aquaculture wastewater into natural water bodies.

4.1.6 Tourism and recreation

As a historic water town in China, Suzhou's tourism development relies heavily on the utilization of water resources (Zhang 2018). Suzhou has strong potential for tourism with many tourist destinations across the city. However, it is also recognized that Suzhou's most popular tourist attractions are located in the historic center, the old town (Kim and Wang 2018). There are 863 statutorily protected heritage properties in Suzhou, but 45% of them are located within Suzhou's old town. Similarly, 39 properties are designated as national heritage, but 24 of these are in the old town (Kim and Wang 2018).

4.1.7 Industrial development

Rapid industrial development has placed tremendous pressure on Suzhou's water environment, especially excessive pollution emissions from traditional local industries such as textile printing, dyeing, and chemical industries. Liu and Zhou (2014) pointed out that many traditional local industries are located at centralized enterprise parks often developed along rivers and lakes, which become severe pollution sources to neighboring water streams. Specifically, in a case study of Luzhi Town, Suzhou, Shen et al. (2014) found that textile printing and dyeing/chemical industries are the top two factors contributing to COD emissions. Moreover, the primary pollutants in the Suzhou section of the Grand Canal are mainly from textile printing, dyeing, chemical production, electronic product manufacturing, and metal manufacturing industries (Lu et al. 2016).

4.1.8 Land use

From 1995 to 2015, farmland in Suzhou decreased by 8.9%, while construction land increased by 7.8% (Fig. 4). Not surprisingly, in the past two decades, most of the reduced farmland was used for urban construction and urban expansion, and a small amount of that was used to supplement forest and water areas (Li and Bai 2018).

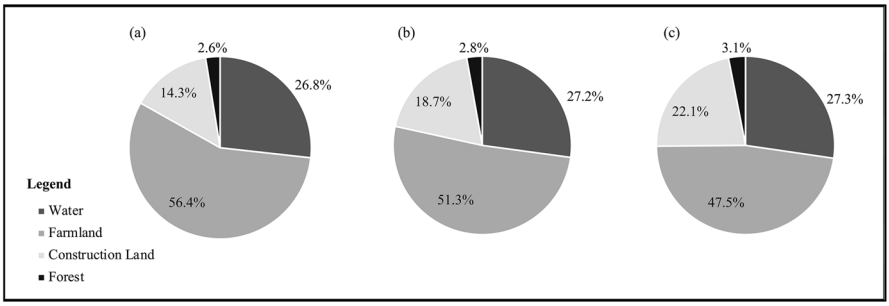

Fig. 4 The composition of land use types in Suzhou in 1995 (a), 2005 (b) and 2015 (c)

4.1.9 Public participation

Public participation in environmental decision-making is increasingly emphasized by the Suzhou government (Suzhou Municipal Government 2015). A Suzhou government survey in 2018 shows that Suzhou citizens are most concerned about air pollution, but only 29% of them pay attention to drinking water safety (Suzhou Municipal Government 2018). With a citizen-as-sensor approach, the government provides an online participation platform to report environmental illegal companies and behavior identified by citizens.

4.2 Legislation analysis

Suzhou's watershed legislation is regulated from national, regional, provincial, and municipal levels (Table 4). Despite the considerable number of laws and regulations related to the water environment and resource protection in China, there is a lack of policies and regulations at the river basin level (Sun 2018). There is also a concern that the Water Law of the People's Republic of China has not reacted fully to the administrative reform on water resources management, mainly because the Water Law regulates more on water environments and activities but less on the institutional arrangement (Wang 2011). However, there have been collective efforts to streamline the watershed legislation. For instance, in 2008, Jiangsu Province implemented Regulations on Water Pollution Control in Taihu (Jiangsu area) to address the blue algae crisis (SIP Lvse Jiangnan Public Environment Concerned Center 2016). Although this provincial regulation helped reduce the total nitrogen and total phosphorus in Taihu, it merely prohibited new construction, renovation, and expansion of printing and dyeing industries in the area. This had the effect of discouraging the upgrade of the entire textile industry chain to be more sustainable. In 2018, with the effort of entrepreneurs, NGOs, and other parties, the regulation was updated to allow existing enterprises to work on technological improvement for discharged phosphorus and nitrogen (SIP Lvse Jiangnan Public Environment Concerned Center 2019).

This research conducted a word frequency analysis for a simpler and more rapid watershed policy review to identify the emphasis and priority presented in the

Table 4 Government policies in Suzhou watershed management

Gov. Level	Government policies and plans in watershed management		Type	
			Law & Regulation	Plan
National & Regional Level	N1	Water Law of the People's Republic of China (2016)	●	
	N2	Regulations on Taihu Basin Management (2011)	●	
	N3	Fishery Law of the People's Republic of China (2013)	●	
	N4	Water Pollution Prevention Law of the People's Republic of China (2018)	●	
	N5	Adjustment Scheme for the National Land Use Master Plan (2006–2020)		●
	N6	The Outline of Flood Control Planning in Taihu Basin (2008–2025)		●
	N7	The 13th Five-Year Plan on Ecological Environment Protection (2016–2020)		●
	N8	The 13th Five-Year Plan on Tourism Development (2016–2020)		●
	R1	Ecological Environment Protection Planning of Yangtze River Economic Belt (2016–2030)		●
Provincial Level	P1	Regulations on Lake Protection of Jiangsu Province (2019)	●	
	P2	Regulations on Prevention and Control of Water Pollution in Taihu of Jiangsu Province (2008)	●	
	P3	Regulations on Tourism of Jiangsu Province (2015)	●	
	P4	Regulations on Flood Control of Jiangsu Province (2017)	●	
	P5	Regulations on Fishery Management of Jiangsu Province (2019)	●	
	P6	General Land Use Planning of Jiangsu Province (2006–2020)		●
	P7	The Planning on National Ecological Protection Red Line of Jiangsu Province (2018)		●
	P8	The 13th Five-Year Plan on Tourism Development of Jiangsu Province (2016–2020)		●

Table 4 (continued)

Gov. Level	Government policies and plans in watershed management		Type	
			Law & Regulation	Plan
Municipal Level	C1	Regulations on Fishery Management of Suzhou (2011)	●	
	C2	Specific Planning on Urban Flood Control of Suzhou (2008–2020)		●
	C3	The Planning on Tourism Standardization Development of Suzhou (2011–2020)		●
	C4	The 13th Five-Year Plan on Ecological Environment Protection of Suzhou (2016–2020)		●
	C5	Water Pollution Prevention Scheme of Suzhou (2016)		●
	C6	The 13th Five-Year Plan on Tourism Development of Suzhou (2016–2020)		●
	C7	The 13th Five-Year Plan on Water Conservancy of Suzhou (2016–2020)		●
	C8	General Land Use Planning of Suzhou (2016–2020)		●
	C9	Implementation Scheme on Ecological River and Lake Action Plan of Suzhou (2018–2020)		●

The year in brackets indicates the time when the document was first issued or revised, and the time period in brackets indicates the planning period. See Appendix 1 for the web page links of all the documents

watershed legislation and policies. Nine domains for the watershed policy framework developed in Table 1 were used to provide a systematic analysis structure. A series of phrases representing each domain were assigned, and the word frequency in each domain was calculated as a percentage of the total word count of all domains. Table 5 and Fig. 5 show the results of the word frequency analysis in three different policy levels: national/regional, provincial, and, municipal levels. Although this analysis method may not provide the policy evaluation outcomes in great detail; however, it is hoped that it provides an objective snapshot of the legislation foci and priorities presented in Suzhou's watershed policies and plans.

It is apparent from these data that the words in the social domain (public; participation; disclosure) are mentioned very little in all three policy levels. On the contrary, the frequency of phrases in three domains (flood control, habitat and biodiversity, and fisheries and agriculture) reports a higher priority and a similar emphasis at the three levels. The water quality domain is more frequently addressed at the national/regional level compared with the municipal level's policy documents. The water resource domain is emphasized less at the provincial level than the other two levels. What stands out in the graph is that the municipal policies place greater importance on tourism, recreation, and industrial development compared with national policies. This may be because those are increasingly important to Suzhou city's economy.

4.3 Stakeholder analysis

Stakeholder analysis identifies key players in the watershed planning stage and involves an assessment of their interests and how they have likely affected the planning process (UNEP 2012). Stakeholder analysis can be conducted qualitatively by involving policy review, meeting observation, and focus groups on understanding stakeholders' perceptions of watershed issues (Borisova et al. 2012). The analysis can also employ a more quantitative approach, such as a decision-analytic model, to promote communication and concerns among different stakeholders (Borsuk et al. 2001). Brugha and Varvasovszky (2000) summarize that stakeholder analysis encompasses a range of different approaches from policy roots (policy and power relation), management roots (influence of stakeholders in organizations), and development roots (relationship between stakeholders for developing alliances with each other). With a focus on an institutional arrangement, this paper conducts a qualitative stakeholder analysis in a management approach to identify the interest and influence of primary stakeholders in the watershed management practice in Suzhou. Two of the present authors have conducted stakeholder analysis through policy and media review, academic literature review, and focus group interviews with local non-governmental organizations (NGOs).[1] Table 6 illustrates the result of the stakeholder analysis for the Suzhou watershed.

[1] For stakeholder analysis, one of the current authors conducted three focus group interviews with SIP Lvse Jiangnan Public Environment Concerned Center (PECC) in October and November 2019.

Table 5 Word frequency analysis for watershed policies

Watershed domain			Words searched (in Chinese)	Word frequency			
				National/Regional Level (%)	Provincial Level (%)	Municipal Level (%)	Average (%)
Domains for Watershed Policy Framework							
Environmental Domain	[1]	Water Quality	Water quality; water pollution	14.6	7.8	5.7	9.4
	[2]	Water Resource	Water resource; water conservancy	11.6	4.2	10.8	9.0
	[3]	Flood Control	Flood	12.3	16.7	14.0	14.3
	[4]	Habitat and Biodiversity	Ecology; biology	22.0	19.0	19.3	20.1
Economic Domain	[5]	Fishery and Agriculture	Fisheries; agriculture; forestry; animal husbandry	14.5	16.7	13.2	14.7
	[6]	Tourism and Recreation	Tourism; recreation	9.8	23.9	19.5	17.5
	[7]	Industrial Development	Industry	6.7	5.2	11.1	7.8
	[8]	Land Use	Land use	5.9	4.4	2.6	4.3
Social Domain	[9]	Public Participation	Public; participation; disclosure	2.6	2.2	3.8	2.9
	Total			100.0	100.0	100.0	100.0

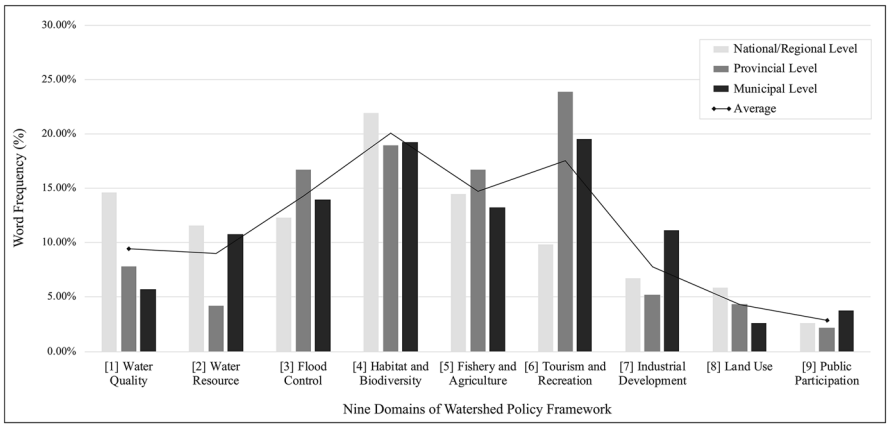

Fig. 5 Word frequency analysis for watershed policies

Watershed organizations must offer various hooks to attract a broader range of stakeholders: a more comprehensive consultation opportunity for regulatory agencies; potential for promoting a positive image for businesses; and an opportunity to strengthen the voice of voluntary groups (Kim 2002). Considering China's local context, it is challenging to divide watershed stakeholders into public and private sector categories. Many state-owned enterprises are operating in the manufacturing, construction, service, and agriculture industries in China. There are also collective enterprises (community-owned) in the rural administration area. Therefore, in this paper, Suzhou's watershed stakeholders are classified under three headings: public administration sector; economic sector; and, social and community sector (Table 6). Those can also be further categorized into three sub-levels depending on their decision-making power influence and the extent of their direct relations in the watershed management issues: primary stakeholder (most directly involved); secondary stakeholder (less directly involved); and, tertiary stakeholder (indirectly involved).

4.4 Analysis summary

Drawn from the results of the situation analysis, legislation analysis, and stakeholder analysis, Fig. 6 illustrates priorities of the key issues identified in the watershed management practice in Suzhou. These issues are evaluated by two dimensions: (1) the importance as established from the situation analysis; and, (2) the emphasis laid on the current government policies. With insights from the authors' global and local expertise, nine watershed domains were categorized into four key issues in Suzhou's watershed revitalization: water resource; tourism and conservation; economic development; and monitoring and stewardship. As the visualization of analysis results can be used as a cognitive strategy to discover unknown factors and solve complex problems (Rieber 1995), it is hoped that the visual representation of the watershed issues can assist better communication among stakeholders and support problem-solving.

Table 6 Stakeholder analysis outcomes

Stakeholder Category			Responsibility	Decision-making Power and Relations		
				Primary	Secondary	Tertiary
Public administration sector	National level	Ministry of Water Resource	Water resource development and conservation			
		Ministry of Natural Resources				
		Ministry of Ecology and Environment	Ecology and water quality protection			
		Taihu Basin-East China Sea Area EESAB	Ecological environment supervision of water resources in Taihu Basin			
		Taihu Basin Authority	Taihu Basin water resource development and conservation			
	Provincial level	Ecology and Environment Department	Ecology and water quality protection			
		Water Resource Department	Water resource development and conservation			
	Municipal level	Suzhou Municipal Committee of CPC	Policy-making and delivery			
		Suzhou Municipal Government				
		Suzhou Ecology and Environment Bureau	Ecology and water quality protection			
		Suzhou Water Affairs Bureau	Water resource conservation and development			
		River Chief System Office	Management and protection of rivers and lakes			
Economic sector	Primary industry	Farmer	Agricultural products producer			
	Secondary industry	Manufacturer and constructor	Manufacturing, construction and installation			
		Water, electricity and gas company	Supplier of water, electricity and gas			
		Polluting enterprise	Pollution controller			
		Environmental Technology Company	Pollution treatment service provider, sensor installer, database creator			
	Tertiary industry	Agricultural supplier	Agricultural products supply			
		Insurance company and bank	Providing insurance or credit for polluting enterprises			
		Hotel, restaurant and real estate developer	Tourism and accommodation service provider			
Social and community sector	NGOs		Policy implementer, supervisor, researcher			
	Local community		Resource user, supervisor			

[Note] Darker gray color represents higher degree engagement, while lighter gray represents a lower degree of engagement.

Darker gray color represents higher degree engagement, while lighter gray represents a lower degree of engagement.

Water quality in the Suzhou watershed has been identified as a primary area for improvement. This is because water quality is related to the other domains of watershed management practice, such as water resource (drinking water), tourism and recreation (image of historic water town), habitat and biodiversity (supporting ecosystem), and land use (sustainable growth). Learning from the experience of global case studies, it is crucial to address the following issues:

- [Issue 1] New institutional arrangements to achieve sustainability (a new strategic partnership with government and non-government bodies);

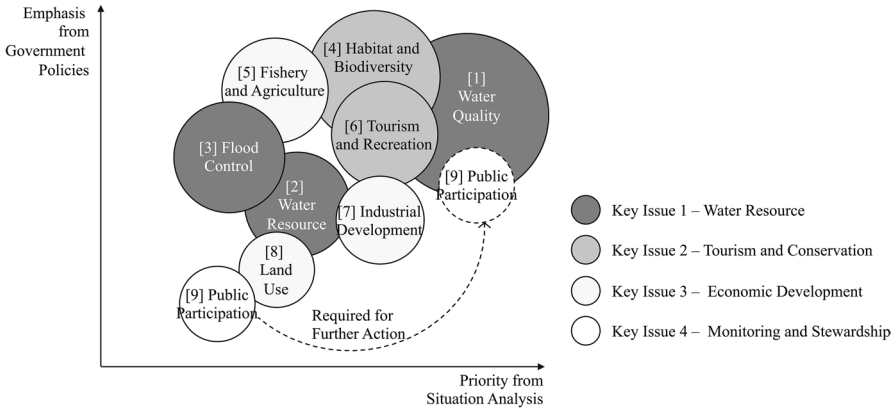

Fig. 6 Watershed management issues of Suzhou

- [Issue 2] Development of integrated policy delivery mechanism at watershed level (this is not about making additional policy for integrated watershed management, but creating a process of delivering the existing policy goals holistically); and
- [Issue 3] More robust public participation on the watershed management practice (local communities must have diverse channels to get involved in the watershed management practice, from the decision-making process to local information sharing).

5 Toward integrated watershed revitalization in Suzhou

Suzhou's watershed requires close attention to improve the water quality and develop the watershed sustainably and holistically. As this is only achievable by collective effort from all stakeholders involved, this research recommends establishing collaborative partnerships and developing an integrated watershed management plan for Suzhou. Reflecting the lessons from global case studies, this section will discuss new institutional arrangements that can promote the sustainability goal (above [Issue 1]) and legislation formation and delivery processes to facilitate wider involvements from diverse stakeholders (above [Issue 2] and [Issue 3]).

5.1 Establishment of Suzhou watershed partnership

This section explores a potential institutional framework involving a collaborative partnership for Suzhou's watershed and considers how this could be implemented. Not involving key stakeholders is a severe limitation to effective collaborative processes in Suzhou's partnership operation. Wider stakeholder involvement in the planning, decision-making, and implementation stages is one of the primary principles contributing to effective collaborative approaches. Most institutional innovations start informally (Innes et al. 1994), and networks are facilitated where individuals

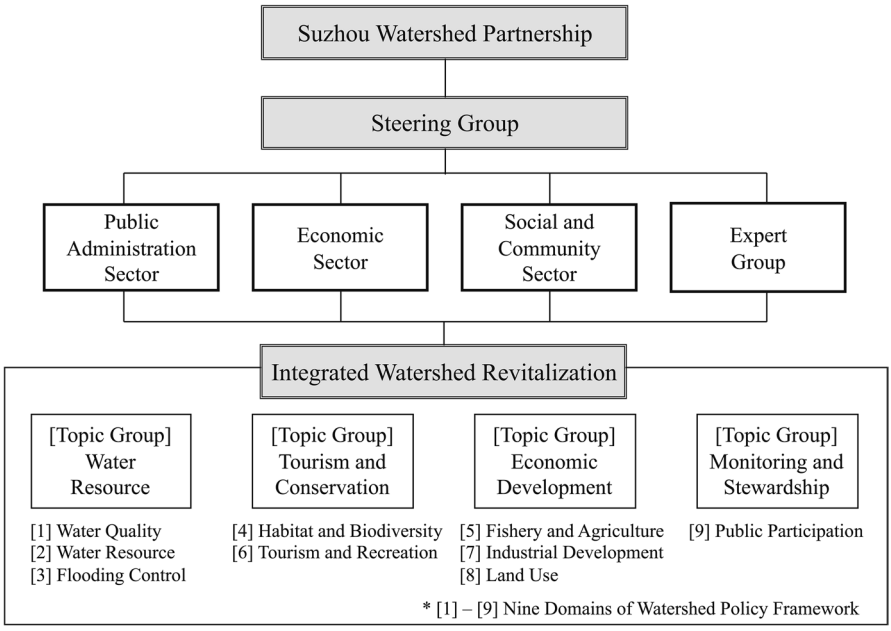

Fig. 7 The potential structure of the Suzhou watershed partnership

have worked together in previous situations, in 'the same (or linked) organizations', or within 'the same geographical area' (Lowndes et al.1997).

A possible way to identify more comprehensive stakeholders is to involve existing local area-based networks or organizations at an early stage to arrange initial contacts to stakeholders within the particular watershed area. This may include the area-based NGOs such as SIP Lvse Jiangnan Public Environment Concerned Center and Suzhou Youth Volunteers Association Volunteers Branch. In this context, the experience of global case studies (especially the Mersey Basin Campaign; Kim 2002) suggests that a watershed conference can help to initiate the formation of a watershed partnership. This kind of watershed conference can promote collaboration between the public, private, and voluntary sectors and the importance of filling the vacuum of leadership in coordinating environmental management in the area. Therefore, the organization of a series of future watershed conferences, together with local and international expert groups, may be an initial but critical action for establishing the watershed partnership in Suzhou.

A partnership generally runs through a steering group (Fig. 7). Establishing a suitable institutional arrangement at an early stage can prevent many potential difficulties that may arise later. As the watershed partnership in Suzhou may cover a larger geographical scale and deals with a complex array of issues, it may be more appropriate to divide the partnership structure into several sub-groups. A multi-level management structure of partnerships should also ensure the environment for communication and co-operation between different bodies or sub-committees.

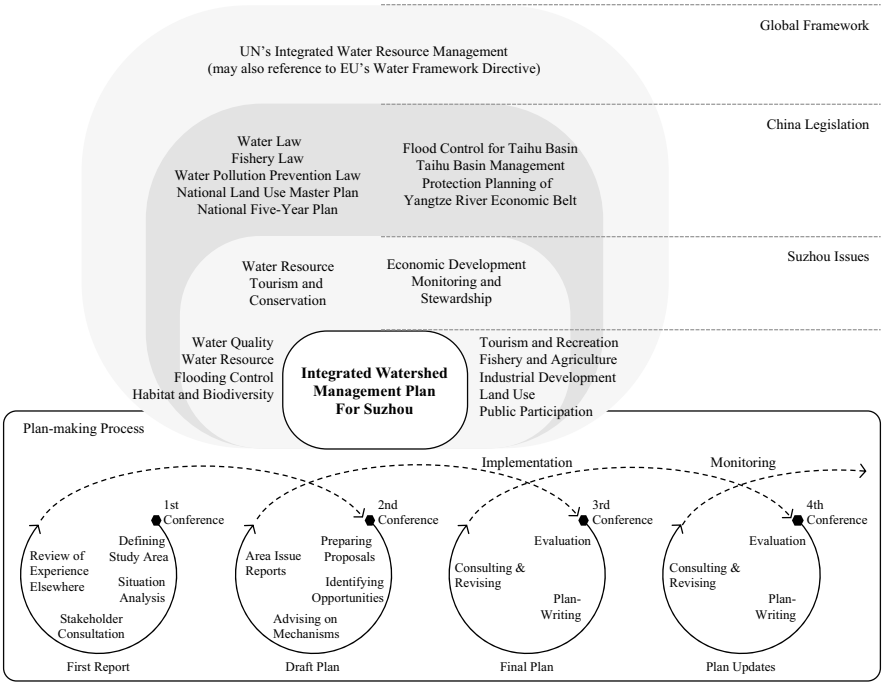

Fig. 8 Legislation and processes relevant to Suzhou's integrated watershed management plan

Considering the results of the situation analysis discussed in the earlier section, the key areas for Suzhou's watershed management (water resource; tourism and conservation; economic development; and monitoring and stewardship) can be a potential structure for the topic groups in the formation of the Suzhou watershed partnership.

5.2 An integrated watershed management plan for Suzhou

Global case studies show that an integrated watershed management plan is the most crucial task for the watershed partnership (Consensus Building in Table 3). An integrated watershed management plan is a visionary policy document coordinated and produced by a collective effort from various stakeholders (Petitcodiac Watershed Alliance 2012). This plan describes the actions required overtime to achieve a sustainable and healthy watershed and provides a roadmap for managing resources with an outlook towards the future. As there is no integrated watershed management plan across jurisdictional boundaries in Suzhou, it will be desirable for the Suzhou watershed partnership to initiate the plan-making. The watershed management plans are not referred to directly in the government legislation. As there are many government policies and regulations to the watershed issues in Suzhou (see Table 4), there is no guarantee that an additional government policy would solve the complex watershed management practice. The

integrated watershed management plan is more about 'steering' the collective efforts toward making Suzhou's watershed sustainable instead of 'controlling' the planning practice. The plan is to make sure 'everybody is singing from the same hymn sheet'. Learning from the work programs of Mersey Estuary Management Plan (Kim 2002; University of Liverpool Study Team 1995), Fig. 8 illustrates the relations between the legislative framework and the plan-making process of the proposed watershed management plan for Suzhou's watershed. This framework is drawn from the proven experience of best practice discussed in the earlier section (see Table 3). It is hoped that this may demonstrate how global best practices can be applied and reproduced to embrace integrated watershed revitalization in Suzhou.

6 Conclusions

This paper had two distinct parts. The first part was intended to capture lessons learned from the experience of global watershed management projects. Twelve watershed projects were explored to evaluate their performance and delivery mechanism. Drawn from nine domains for the watershed policy framework identified in the earlier sections, the second part investigates the current situation of the particular practice of integrated watershed revitalization in Suzhou, China. This is to develop guidelines to assist the concrete practice by embracing the watershed partnership arrangement principles and the making of the integrated watershed management plan learning from global case studies.

Applying a partnership instrument to watershed management practice in China is not common, although it is the most popular approach in the international context. A partnership approach in China is more widely applied to economic development and real estate development projects. With limited experience in operating environmental partnerships in China, the remaining question is how diverse stakeholders in the watershed, hoping to achieve sustainability principles, can act more effectively together in the face of political inequality. Global case studies found that a well-managed consensus building process is fundamental. Understanding and learning are essential to enable individual members of the watershed partnership to value and contribute to a broader vision for the whole basin rather than a single organization's narrow view. Many researchers reported that networks developed through pre-existing organizations were essential to establish a new partnership in the area. There is evidence that where networks exist, broadly based forms of collaborative planning can develop rapidly (Healey et al. 1997).

While integrated watershed management practice has not fully matured in China's political environment, China has a widespread business culture based on trustworthiness, often called 'guanxi' in Chinese. Those informal networks have been used as a problem-solving tool, and 'guanxi' networks are widely recognized as a fundamental component of traditional Chinese social structure (Barbalet 2014). A carefully crafted 'guanxi' network in the operation of a watershed partnership may help overcome the information-sharing barrier, further stimulating stakeholders' participation. Learning from global case studies and embracing local political and

cultural contexts, the collaborative partnership approach can be resilient for new challenges in delivering integrated watershed revitalization in China.

Appendix 1

Government documents		Sources
N1	Water Law of the People's Republic of China (2016)	http://www.yueyang.gov.cn/yyx/37584/38154/38157/38160/38177/38190/40023/content_1361938.html
N2	Regulations on Taihu Basin Management (2011)	http://www.mwr.gov.cn/zw/zcfg/xzfghfgxwj/201707/t20170713_955727.html
N3	Fishery Law of the People's Republic of China (2013)	http://www.npc.gov.cn/wxzl/gongbao/2014-06/20/content_1867661.htm
N4	Water Pollution Prevention Law of the People's Republic of China (2018)	http://d.wanfangdata.com.cn/claw/G000258871
N5	Adjustment Scheme for the National Land Use Master Plan (2006–2020)	http://d.wanfangdata.com.cn/claw/G000233763
N6	The Outline of Flood Control Planning in Taihu Basin (2008–2025)	https://wenku.baidu.com/view/abfb0d2058fb770bf78a55bc.html
N7	The 13th Five-Year Plan on Ecological Environment Protection (2016–2020)	https://wenku.baidu.com/view/06a0bdf1178884868762caaedd3383c4ba4cb413.html
N8	The 13th Five-Year Plan on Tourism Development (2016–2020)	http://www.gov.cn/zhengce/content/2016-12/26/content_5152993.htm
R1	Ecological Environment Protection Planning of Yangtze River Economic Belt (2016–2030)	http://www.mee.gov.cn/gkml/hbb/bwj/201707/W020170718547124128228.pdf
P1	Regulations on Lake Protection of Jiangsu Province (2019)	http://www.jiangsu.gov.cn/art/2019/1/28/art_59202_8127398.html
P2	Regulations on Prevention and Control of Water Pollution in Taihu of Jiangsu Province (2008)	https://wenku.baidu.com/view/a97ee9c56137ee06eff91871.html
P3	Regulations on Tourism of Jiangsu Province (2015)	http://www.pkulaw.cn/fulltext_form.aspx?Gid=17919775
P4	Regulations on Flood Control of Jiangsu Province (2017)	http://www.jsrd.gov.cn/zyfb/sjfg/201706/t20170607_463295.shtml
P5	Regulations on Fisheries Management of Jiangsu Province (2019)	https://duxiaofa.baidu.com/detail?searchType=statute&from=aladdin_28231&originquery=%E6%B1%9F%E8%8B%8F%E7%9C%81%E6%B8%94%E4%B8%9A%E7%AE%A1%E7%90%86%E6%9D%A1%E4%BE%8B&count=42&cid=1c258ce58a559464b8e8728c0b711958_law
P6	General Land Use Planning of Jiangsu Province (2006–2020)	http://g.mnr.gov.cn/201807/t20180720_2115893.html
P7	The Planning on National Ecological Protection Red Line of Jiangsu Province (2018)	http://www.xy.gov.cn/xy/uploadfile/dc5a3879-c5bb-4fec-b6d3-8de01df0259b/20180627095410995.pdf
P8	The 13th Five-Year Plan on Tourism Development of Jiangsu Province (2016–2020)	http://www.ce.cn/culture/gd/201708/10/t20170810_24929107.shtml

Government documents	Sources
C1 Regulations on Fisheries Management of Suzhou (2011)	https://duxiaofa.baidu.com/detail?searchType=statute&from=aladdin_28231&originquery=%E8%8B%8F%E5%B7%9E%E5%B8%82%E6%B8%94%E4%B8%9A%E7%AE%A1%E7%90%86%E6%9D%A1%E4%BE%8B&count=31&cid=f8e14666fdb132322f6cc6a463e41e77_law
C2 Specific Planning on Urban Flood Control of Suzhou (2008–2020)	http://www.zfxxgk.suzhou.gov.cn/sjjg/szsslj/201212/t20121210_182624.html
C3 The Planning on Tourism Standardization Development of Suzhou (2011–2020)	http://www.itripsh.com/article/18337/23.html
C4 The 13th Five-Year Plan on Ecological Environment Protection of Suzhou (2016–2020)	http://www.suzhou.gov.cn/szsrmzf/zfbgswj/201701/9660baf5d2244ce4b1c54a3e5dab4859.shtml
C5 Water Pollution Prevention Scheme of Suzhou (2016)	http://www.zfxxgk.suzhou.gov.cn/sxqzf/szsrmzf/201604/t20160429_710522.html
C6 The 13th Five-Year Plan on Tourism Development of Suzhou (2016–2020)	http://www.suzhou.gov.cn/szsrmzf/zfbgswj/201702/2f888f9dd749412f9b70edc6cf11fbdf.shtml
C7 The 13th Five-Year Plan on Water Conservancy of Suzhou (2016–2020)	http://www.h2o-china.com/news/252410.html
C8 General Land Use Planning of Suzhou (2016–2020)	https://max.book118.com/html/2017/1108/139352926.shtm
C9 Implementation Scheme on Ecological River and Lake Action Plan of Suzhou (2018–2020)	http://www.suzhou.gov.cn/gzcy/myzj/mydc/lfzqyj/201804/t20180409_973386.shtml

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